

Description

Axial piston machine

The invention relates to an axial piston machine in accordance with the preamble of claim 1.

Axial piston machines of this type known, for instance, from WO 03/058034 A1 comprise two cylinder drums in each of which a plurality of cylinders is formed. A shaft which is fixedly connected to a plurality of pistons confining a respective pressure chamber by the cylinders of the cylinder drums passes through the two cylinder drums. The cylinder drums are supported on inclined surfaces the inclination of which is selected such that the axis of rotation of the cylinder drums is inclined with respect to the shaft axis. The inclined surfaces supporting the cylinder drums do not rotate together with the shaft or the cylinder drum so that the pistons pass an elliptic track of motion with respect to the plane of the inclined surfaces supporting the cylinder drums. In the known solutions the cylinder drums are located with the pistons between the two inclined surfaces, the latter being respectively formed on control disks which are supported on the housing of the axial piston pump and via which pressure is supplied and released.

When testing the known axial piston machines it turned out that in operation of the axial piston machine the noise emission is relatively high so that insulating measures have to be provided. It is another drawback of the known solutions that the pressure supply via the two external control disks requires a comparatively complex design of the pressure and tank channels.

Compared to this, the object underlying the invention is to provide an axial piston machine having a comparatively simple design in which the noise emission is reduced vis-à-vis conventional solutions.

This object is achieved by an axial piston machine comprising the features of claim 1.

In accordance with the invention, two cylinder drums of the axial piston machine are formed on respective inclined surfaces, wherein said inclined surfaces are arranged centrally, i.e. in the area between the two cylinder drums, and a pressure channel and a tank channel end in said inclined surfaces. By way of this central arrangement of the inclined surfaces the ducting can be considerably facilitated compared to the conventional solutions so that the costs of manufacturing the axial piston machine are comparatively low. It is another advantage that by the central arrangement the forces of pressure acting on the two inclined surfaces are substantially mutually neutralized so that the pressure forces introduced into the housing via the inclined surfaces are very small and, accordingly, also the noise emission is reduced which, in conventional solutions, can adopt an unacceptable degree by the forces introduced via the external control disks into the housing having large noise-radiating surfaces.

In the case of an especially compact variant the two end faces are formed on a control disk which is centrally inserted in the housing and through which a shaft supporting the pistons passes.

For further reducing the noise emission an insulating layer can be provided between the control disk and the housing. In such an embodiment it is preferred when the control disk includes a protection against torsional twist in the form of a flattened portion, for instance.

In order to prevent a relative twisting of the resiliently supported control disk inside the housing, it is preferred in this solution to arrange and design the central pressure ports such that the forces acting via the pressure ports, especially the pressure port on the control disk, are so great that the torques transmitted by rotation of the cylinder drum to the control disk are substantially compensated.

In the case that the axial piston machine is to be operated as pump or hydraulic motor the control disk has two kidney-shaped control members one of which is allocated to a pressure port and the other is allocated to a tank port. In a

variant of the invention it is preferred when the channels connected to the pressure and tank ports tangentially end in the kidney-shaped control members.

The axial piston machine can be basically operated as hydraulic transformer as well. However, this requires that the control disk is rotatably accommodated in the housing and that it includes three kidney-shaped control members.

Other advantageous further developments of the invention are the subject matter of further subclaims.

Hereinafter preferred embodiments of the invention will be illustrated by way of schematic drawings in which:

Figure 1 shows a schematic longitudinal section across a first embodiment of an axial piston machine;

Figure 2 shows a simplified sectional representation of the axial piston machine from Figure 1;

Figure 3 shows an enlarged detailed representation of the axial piston machine from Figure 1 and

Figures 4, 5 are representations of a second embodiment of an axial piston machine corresponding to the Figures 1 and 2.

In Figure 1 a simplified longitudinal section across a first embodiment of an axial piston machine 1, for instance a hydraulic pump, is shown. Figure 2 illustrates a section, which is geometrically not exact, along the dot-dash vertical line y in Figure 1. Accordingly, the axial piston machine 1 has a housing 2 in which a shaft bore 4 is formed. In the latter a shaft 6 is supported by two shaft bearings 8, 10. Said shaft 6 (drive shaft in a pump) supports two cylinder drums 12, 14 the rotational axes Z1 and Z2 of which are inclined with respect to the rotational axis X of the shaft 6.

The two cylinder drums 12, 14 inclined with respect to each other are supported on a control disk 16 accommodated centrally (view according to Figure 1) in the housing 2. The end faces of said control disk 16 are formed by two inclined surfaces 18, 20. According to Figure 1, these inclined surfaces 18, 20 are inclined with respect to each other in such manner that the control disk 16 is tapered downwards from the radially upper portion of the housing 2.

Each cylinder drum 12, 14 has a plurality of cylinders 22 and 24, respectively, in each of which a piston 26, 28 immerses. The pistons 26 and 28, resp., allocated to the cylinder drums 12, 14 are arranged axially in parallel to the shaft axis X and are mounted on a flange 30, 32 which is formed integrally with the shaft 6 or is mounted on the same. The pistons 26, 28 confine by the cylinders 22, 24 a respective pressure chamber 34, 36 which is adapted to be connected – as described in detail hereinafter – to a pressure port P or a tank port T. In the sectional representation of Figure 2 the two ports T, P are arranged at the cylinder housing 2 in the central plane including the central axis Y. The two ports P, T are connected to a respective kidney-shaped control member (tank control member 42 and pressure control member 44) via a tank channel 38 and a pressure channel 40, respectively. In accordance with Figure 2, the two channels 38, 40 tangentially end in the allocated kidney-shaped control member 42 and 44, respectively. The latter encompass the shaft 6 in portions so that a respective land 46, 48 of the control disk 16 remains between the end portions thereof arranged at the top in Figure 2 and the end portions thereof arranged at the bottom in Figure 2. The two control members 42, 44 end in the respective two inclined surfaces 18, 20.

As one can take especially from Figure 1, the axial piston machine 1 has a symmetric design with respect to the Y axis, wherein the control disk 16 is centrally arranged at the inclined surfaces 18, 20 of which the two cylinder drums 12, 14 are supported. Said cylinder drums interact with the pistons 26, 28 which are fixedly connected to the shaft 6 via the flange 30 and 32, respectively.

Since the structure of the two cylinder drums 12, 14 is identical, constructional details will be illustrated by way of the enlarged representation according to Figure 3 showing the cylinder drum 14. Accordingly, the latter has a drum plate 50 which is

slidingly supported on the inclined surface 20 of the control disk 16 by its end face 52 shown on the left in Figure 3. The drum plate 50 has a mounting hub 54 which is supported on a domed, i.e. convexly curved bearing portion 59 of the shaft 6 by a self-aligning bearing 56 or the like. This self-aligning bearing 56 permits an inclination of the axis Z2 of the rotational axis of the cylinder drum 14 vis-à-vis the shaft axis X. An annular drum body 60 on which the cylinders 24 of the cylinder drum 14 are formed is supported on an annular end face 58 of the drum plate 50 which is internally confined by the mounting hub 54. Said drum body 60 can be composed of a plurality of individual elements. In the solution known from WO 03/058034 A1 this drum body 60 is formed of a plurality of cylinder sleeves, for instance, which are interconnected by a holding ring. The cylinder sleeves can also be supported on the drum plate 50 via spring bias and a joint. Basically the drum body 60 can also be integrally formed.

As indicated in Figure 3, the drum body 60 or the individual elements thereof forming the cylinder 24 are not in full-surface contact with the annular end face 58 but are only in contact by a contacting portion formed by a projection 62.

As mentioned in the foregoing, in the drum body 60 a plurality of cylinders 24 is formed in which the end portions of the pistons 28 immerse so that respective pressure chambers 24, 36 are confined by the cylinders 24 and the pistons 28. The pressure chamber 36 located at the bottom in Figure 3 has the maximum volume (piston provided in its outer dead-center position), while in the relative position between the piston 28 and the cylinder 24 shown at the top of Figure 3 the pressure chamber 36 has its minimum volume (piston provided in its inner dead-center position).

Pressure is supplied to said pressure chambers 36 of the cylinders 24 via sockets 62 passing through the bottom of the cylinder chambers 24 and being slidingly supported on the inner end face of the respective cylinder 24 of the drum body 60 by a radial projection 64. The end portion of the socket 62 distant from the radial projection 64 is inserted in an appropriately designed seat 66 of the drum plate 50. A connecting channel 68 adapted to be connected to the kidney-shaped pressure

control member 44 or tank control member 42 depending on the rotary position of the cylinder drum 14 ends in this seat 66.

Each piston 28 includes a mounting portion 70 via which it is supported in the flange 32 of the shaft 6. Subsequent to the mounting portion 70 the piston 28 is radially set back and is transformed into a tapered portion 72 by which the piston 28 is extended up to its maximum cross-section. Said maximum cross-section is provided with the reference numeral 74 in Figure 3. Subsequent to said maximum cross-section 74 the piston is somewhat tapered again. This tapered shape of the pistons 28 is necessary so that they do not collide with the cylinder walls in the inner dead-center position (top of Fig. 3). In accordance with Figure 3, the pistons are adjacent to the inner circumferential surfaces of the cylinders 24 along their maximum cross-section. For improving the seal a respective piston ring may be provided at the outer circumference of the pistons 28 in this contacting area.

When driving the shaft 6 the pistons 26, 28 rotate about the shaft axis X, whereas the two cylinder drums 12, 14 rotate about their axis Z1 and Z2, respectively. During this movement of rotation the cylinder drums are supported on the central control disk 16. By the inclination of the cylinder drums 12, 14 the pressure chamber located at the top in Figure 3 is enlarged upon further rotation (suction), while the lower pressure chamber 36 is reduced (pressure build-up). The control disk 16 is arranged so that the kidney-shaped tank member 42 is connected to the enlarging pressure chambers and the pressure control member 44 is connected to the reducing pressure chambers. In the area of the dead-center positions (Figure 3) the connection to the two ports P, T is blocked by the lands 46, 48 so that a change-over between pressure port and tank port and vice versa can be carried out.

Due to the inclination of the cylinder drums 12, 14 the pistons 26, 28 pass an elliptic orbit with respect to the allocated inclined surfaces 18, 20. The drum body 60 is designed such that the elements forming the cylinders can slightly slide off along the annular end face 58 so as to compensate for these relative movements.

The essential difference between the solution according to the invention and the known solutions described in the beginning is that pressure is supplied centrally via the control disk 16 and that by the symmetric central design of the control disk 16 the pressure forces transmitted by the two cylinder drums 12, 14 are largely neutralized. The pressure forces acting on the pistons 26, 28 are introduced to the shaft 6 via the flanges 30, 32, i.e. the pressure forces are not guided via the housing including its large noise-radiating surfaces. It is another substantial advantage of the invention that the pressure fluid channels can be arranged very simply and spaced very closely by the centrally located ports so that the structure of the axial piston machine is substantially facilitated vis-à-vis the known solutions.

The noise radiation during operation of the axial piston machine can be further improved by the embodiment illustrated by way of the Figures 4 and 5.

The embodiment shown in Figures 4 and 5 substantially differs from the afore-described embodiment merely by the design of the control disk 16 and the ducting in the control disk 16. The structure of the cylinder drum 12, 14 and the shaft 6 is identical to the above-described embodiment so that hereinafter only the differences will be discussed.

In the embodiment shown in Figures 4 and 5 the control disk 16 is neither mounted directly in the housing 2 nor is it formed integrally with the same, but it is a separate component part, wherein in the mounted state an insulating layer is formed between the housing 2 and the control disk 16. Said layer can be made, for instance, of elastic synthetic material having sound-insulating characteristics. For protecting the control disk 16 against twisting it is provided with a flattened portion 78; a recess 80 of the housing 2 is appropriately designed. The elastic insulating layer 76 is inserted in said recess 80 and encompasses the outer circumference of the control disk 16. By decoupling the control disk 16 from the housing 2 the noise emissions can be further reduced, to be sure, in the case of unfavorable operating conditions, however, a relative twist can occur between the control disk 16 and the housing 2 despite the flattened portion due to the elasticity of the insulating layer 76. In order to prevent this, the ports T, P are located such that the pressure forces acting on the control disk 16 via the two ports T, P (especially P) can compensate for this torque. I.e. the axial

distance a and the cross-sectional area of the pressure channel 40 are selected, for instance, such that the pressure force F_H transmitted via the pressure fluid at the control port P to the control disk 16 generates a torque ($F_H \times a$) which compensates for the radial force acting on the control disk 16 during operation and the torque resulting therefrom. Of course, also other measures for supporting the torque can be provided.

An axial piston machine is disclosed comprising two cylinder drums which are guided in a housing, can be respectively rotated about a drum axis and are respectively supported on an inclined surface arranged in the direction of a shaft rotational axis. In accordance with the invention, said inclined surfaces are located in the region between the two cylinder drums and the channels for supplying and releasing pressure end in said two inclined surfaces, i.e. pressure is supplied and released centrally.

List of reference numerals:

1	Axial piston machine
2	housing
4	shaft bore
6	shaft
8	shaft bearing
10	shaft bearing
12	cylinder drum
14	cylinder drum
16	control disk
18	inclined surface
20	inclined surface
22	cylinder
24	cylinder
26	piston
28	piston
30	flange
32	flange
34	pressure chamber
36	pressure chamber
38	tank channel
40	pressure channel
42	kidney-shaped tank control member
44	kidney-shaped pressure control member
46	land
48	land
50	drum plate
52	end face
54	mounting hub
56	self-aligning axis
58	annular end face
59	bearing portion
60	drum body

62	socket
64	radial projection
66	seat
68	connecting channel
70	mounting portion
72	tapered portion
74	maximum cross-section
76	insulating layer
78	flattened portion
80	seat